SKF ROLLER BEARING DIVISION
SKF INDUSTRIES
SHIPPENSBURG, PENNSYLVANIA

ADDENDUM TO THE OCTOBER 1984 GROUND WATER STUDY

-PRELIMINARY-

PREPARED BY:
NASSAUX-HEMSLEY, INCORPORATED
56 NORTH SECOND STREET
CHAMBERSBURG, PENNSYLVANIA

NOVEMBER 1985

INTRODUCTION

In October 1984, Nassaux-Hemsley, Incorporated completed a study of the source and extent of TCE contamination of ground water at the Shippensburg Plant of the SKF Roller Bearings Division of SKF Industries. In a March 5, 1985, letter, Mr. Robert Benvin, of the Pennsylvania Department of Environmental Resources (PaDER), presented four (4) concerns about the study, which are addressed by this Addendum to the original report.

ADDITIONAL SAMPLING

To answer the concerns raised by PaDER, the five (5) monitoring wells installed for the original ground water study were pumped and sampled on October 8, 1985. These samples were analyzed by Lancaster Laboratories for 27 volatile organics, 16 metals, and the key anions Chloride and Sulfate. Electrical conductivity (E.C.) was also measured in the field. These data are summarized on the following table and the laboratory reports are included at the end of this Addendum.

DISCUSSION

The original study centered on TCE. The clean-up program instituted at the Shippensburg Plant has included installation of an air-stripping tower prior to the cooling water injection well and removal of contaminated soil. This program has been effective as TCE was not detected by Lancaster Labs at any of the five (5) monitoring wells. Continued monitoring through future major recharge episodes will determine if all significantly

contaminated soil has been removed. If it has, wet weather should not bring about a reoccurrence of significant TCE in ground water.

The detailed sampling conducted for this Addendum disclosed only the Trihalomethanes Chloroform (Trichloromethane) and Dichlorobromomethane in ground water. These two constituents were found at levels of 71 ppb and 2 ppb at MW2, while only Chloroform was found at 1 ppb at Well MW1. SKF uses Chlorine in its wastewater treatment process and is clearly a potential source of Chloroform and the other Trihalomethane as well. Chloroform was detected in the contaminated soil in the sludge bed area. However, MW2 is, by virtue of high water level, an upgradient well. In addition, MW2 exhibits gross inorganic chemistry which is significantly different then the other wells. Specifically, E.C., Calcium, and Magnesium are lower at MW2 which indicates that it is in a different zone of water quality then the other wells. It is, therefore, not clear as to whether or not the elevated Chloroform in MW2 is related to on-site or to upgradient activities.

However, with an MCL for Chloroform of 100 ppb, and with Chloroform ubiquitous in public drinking water supplies, a concentration of 71 ppb at MW2 is not exciting.

Continued monitoring will determine whether or not further investigation of the source of the Chloroform in MW2 is warranted.

The analyses disclosed elevated Chloride and Sulfate in downgradient well MW1. This explains the anomalously high E.C. at MW1 noted in the original report and discussed further in the next section of this Addendum. While the source for this is unclear, the levels are well within drinking water limits.

Metals detected above drinking water limits included Iron, Aluminum, and Manganese which were elevated only at MW1. Samples were field acidified for metals, but were not field filtered.

The sample from MW1 was turbid, and the Iron, Aluminum, and Manganese were probably stripped from suspended soil particles when the sample was acidified.

Sodium is somewhat elevated in MW1, and this is believed to be related to the elevated Chloride and Sulfate.

The overall water quality pattern at SKF Indicates that the past TCE problem is under control subject to continued monitoring. No other contaminants were found at levels high enough to warrant any action beyond continued monitoring.

SKF ROLLER BEARINGS DIVISION
SHIPPENSBURG
OCTOBER 8, 1985 WATER QUALITY SURVEY

PARAMETER	WELL #1	WELL #2	WELL #3	WELL #4	WELL #5	DRINKING WATER LIMIT
METALS:						
Aluminum	3.8*	0.3	0.4	0.1	0.2	N/A
Barium	0.063	0.011	0.033	0.033	0.051	1.0
Calcium	92.2	17.5	79.8	84.3	90.5	N/A
Cadmium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.01
Chromium	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05
Copper	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	1.0
Iron	21.0*	0.30	2.94	0.27	0.20	0.3
Lead	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05
Magnesium	19.1	3.26	17.5	15.3	15.9	N/A
Manganese	0.64*	0.005	0.019	< 0.005	< 0.005	0.05
Molybdenum	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	N/A
Nickel	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	N/A
Potassium	2.8	1.0	2.2	1.9	2.1	N/A
Silver	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05
Sodium	13.9	4.8	3.8	3.4	7.4	N/A
Zinc	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	5.0
KEY ANIONS:						
Chloride	67	7	15	13	20	250
Sulfate	100	20	40	30	30	250
FIELD E.C.	811 859**	163	599	584	649	N/A
VOLATILES	All Below Detection Limits	71 ppb Chloroform 2 ppb Dichlorobromomethane	All Below Detection Limits	All Below Detection Limits	1 ppb Chloroform	< 100 ppb Trihalomethanes

*Samples were not field filtered, although they were acidified in the field. Well #1 produces turbid water and the anomalously high Aluminum, Iron, and Manganese is believed to have been stripped from suspended soil by the acid.

**Reading taken 10/13/85 of clear water after solids settled.

RESPONSES TO
PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES
MARCH 5, 1985 LETTER

PaDER QUESTION NUMBER 1:

Page 10 - Specific conductivity is a measure of the dissolved material in water. Turbidity in a well is usually the result of suspended or settleable solids. We do not understand how the turbidity of the water is causing the higher conductivity in MW1. Analysis of a rather complete suite of inorganic parameters would seem important to illuminate the cause of the higher conductivity. Also, the sample could be allowed to settle and then a conductivity reading taken of the clear portion to determine if there is a drop in conductivity. Because of the position of MW1 downgradient from the bulk of plant activities at SKF and also downgradient from the injection well, the possibility of some inorganic degradation of groundwater in the vicinity of the plant should not be dismissed lightly. More clarification is requested from the consultant.

RESPONSE:

Although our past experiences include cases where turbid water had somewhat higher conductivity than equivalent clear water, the additional data collected for this Addendum confirms that the higher conductivity of the water from MW1 is the result of higher dissolved solids and not turbidity. The turbid water had a conductivity of 811 micromhos/cm at the time of sampling while after five (5) days of settling time the clear water had essentially the same conductivity (859 micromhos/cm). MW1 yielded water with 67 mg/l Chloride and 100 mg/l Sulfate, while the other wells produced water with only 7-20 mg/l Chloride and 20-40 mg/l Sulfate.

Other than elevated Iron, Aluminum and Manganese, which were probably stripped from soil in the solids fraction by the acid fixative, no other parameters in MW1 are at a level of concern.

PaDER QUESTION NUMBER 2:

Pending the results of the sludge bed and soil clean-up, I would see nothing wrong with a well located at the exact area of the sludge beds to determine water quality directly beneath the sludge beds. Such a well could also be used as an observation well for a pumping test on the pumped well to ascertain to what extent the pumping is influencing drawdown in the vicinity of the sludge beds, the presumed source of contamination. If badly contaminated, this well could also be used as an additional recovery well. The pumping well is located quite close to the sludge beds, but because the limestone is potentially so anisotropic, there is some doubt that it reflects worse groundwater quality conditions. There is also a question whether the pumping well is acting optimally as a contamination recovery well. The consultant's comments are requested.

RESPONSE:

While drilling an additional well in the sludge bed area is appealing from a scientific standpoint, it could result in more harm then good if not carefully constructed. Improper grouting of the casing could result in a short-circuiting of shallow contaminants retained in the soil in this area into the bedrock aquifer.

While it is certainly possible to drill and construct such a well, it will be expensive. We, therefore, recommend resorting to this additional expense only if the existing clean-up program is not effective as determined by the peripheral network of monitoring wells.

PaDER QUESTION NUMBER 3:

What is the rationale for doing a rather complete suite of analyses downgradient of the plant at Spring Nos. 2, 3, 4, 5, and MW5; and doing only TCE at the plant site wells? There may be other organic contaminants (e.g. DCE) at the plant site which have lower drinking water standards than the TCE. Until the well is sampled for a more complete analysis of volatile organics, it may be erroneous to conclude that groundwater recovery is not needed or that simply limiting TCE contamination to 4.5 ppb or less constitutes adequate response to groundwater pollution abatement.

RESPONSE:

There was no rationale for this difference in analyses at certain sampling stations, the difference happened by accident. The laboratory was instructed to analyze for TCE in each set of samples. In the first set, they did analyze only for TCE, while in the second set consisting of Spring No. 2, 3, 4, 5, and MW5, they analyzed for an extensive list of volatiles despite the request to analyze only for TCE. As we had the more extensive data for some stations, we presented it in the original report rather than present only the data for TCE.

The scope-of-work for the original ground water study was approved by the Bureau of Water Quality Management. That scope included only analyses for TCE. The analyses for 27 volatile organics completed for this Addendum disclosed only the Trihalomethanes Chloroform (Trichloromethane) and Dichlorobromomethane in MW2 and MW5. TCE and the other 24 volatiles were below detection limits at all five monitoring wells.

PaDER QUESTION NUMBER 4:

The study does not establish with any certainty that recovery at the pumping well will contain and eventually recover all TCE contaminated groundwater. It appears likely that some groundwater contaminated above drinking water standards will not be recovered under the current proposal. Over 50% of the inferred area of groundwater contamination lies downgradient of the injection well and will likely be left to migrate downgradient. Dilution, dispersion, and perhaps some microbial decomposition would be relied upon to reduce this "unrecovered" portion of the contaminant plume to acceptable quality.

RESPONSE:

We agree. The original study contained a water table contour map which showed that the "plume" extended downgradient beyond the area of influence of the pumping well. In addition, the first paragraph on Page 12 of the original study stated "...significant recirculation from the injection well to the pumping well is not occurring". It is our opinion, however, that the pumping well is capturing most of the contaminated recharge from the old sludge bed area, due to the proximity of the well to these old beds.

Because of the relatively low level of TCE in ground water, the clean-up program did not call for wholesale ground water recovery, but only an airstripping tower to remove volatiles from the reinjected cooling water and removal of the source of the TCE, i.e. the contaminated soil. This program has been effective to date and has resulted in a reduction in TCE in all wells to below detection limits according to the October 1985, analysis by Lancaster Laboratories. Continued monitoring through major recharge episodes will determine whether or not all of the significantly contaminated soil has been removed.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF SOLID WASTE MANAGEMENT
One Ararat Boulevard
Harrisburg, Pennsylvania 17110
(717) 657-4588
March 5, 1985

Mr. Thomas E. Taylor
Manufacturing Engineer Superintendent
SKF Roller Bearings Division
King Street (West)
Shippensburg, PA 17257

Re: SKF Closure Plan and Study of Groundwater Contamination
Shippensburg Facility
I.D. No. PAD 003026606
Franklin County

Dear Mr. Taylor:

We have reviewed the Closure Plan and Groundwater Study which you submitted on November 1, 1984 and are providing the following comments:

A. Closure Plan:

1. Based on the results of analyses of samples collected by Joel Steigman on October 29, 1984, it is obvious that lateral migration of TCE has not been prevented by the clay soil. This is evidenced by the fact that the soil at a 4 foot depth (DER Sample No. 2313092) from the area adjacent to sludge bed No. 1 contains a high concentration of TCE (88 mg/kg). Also, the clay soil at a much shallower level is contaminated with TCE (DER Sample No. 2313093 - 1.6 mg/kg). Based on these two samples and composite samples 2, 3, and 4, analyzed by Lancy Laboratories, it appears that there has been extensive lateral migration of TCE on the site into surface and sub-surface soils.

   The Lancy analysis of the composite soil sample taken from beneath the lagoons reveals a concentration of 215 mg/kg of TCE. According to the closure plan, a clay liner does exist beneath these lagoons, and no appreciable migration of TCE contamination to levels beneath the liner is anticipated. Soil sampling and analysis should be performed to confirm this. Generally, clay liners have little or no effect on migration of organic solvents such as TCE.

Before the contamination at this site can be satisfactorily remedied, the extent of TCE contamination in the soil should be addressed with respect to depth (vertical migration) and area (lateral migration). TCE contamination appears to be much more extensive than the closure plan reveals. Excavation of only 3 feet of soil from under the filter beds is not acceptable.

Using MEGs methodology, the estimated permissible concentration for TCE is 5.6 mcg/kg in soil. This is based on the 10^{-6} cancer risk level of TCE listed in EPA's Priority Pollutant Water Quality Criteria.

2. According to Page 17 of the closure plan, contamination of soil is defined as TCE concentrations in the soil exceeding 300 mcg/kg. This is based on the TCE concentration in the background sample of 280 mcg/kg. TCE is not a naturally occurring compound; therefore, true background should indicate a level less than detection. A level of 280 mcg/kg of TCE in the soil indicates that there is contamination in the soil. Assuming no sampling or laboratory error has been made, this means that the background soil has been contaminated possibly by lateral migration from the filter beds or by some other means. Again, contamination may be more extensive than believed. This should be addressed.

3. Appendix A indicates that sample 1 from under the filter beds is contaminated with perchloroethylene (4670 mcg/kg) and chloroform (980 mcg/kg) in addition to trichloroethylene (215 mg/kg). These two contaminants have not been addressed.

4. Verification sampling of soil after excavation of the filter beds and underlying soil should include trichloroethylene, perchloroethylene and chloroform.

B. Groundwater Study:

1. Page 10 - Specific conductivity is a measure of the dissolved material in water. Turbidity in a well is usually the result of suspended or settleable solids. We do not understand how the turbidity of the water is causing the higher conductivity in MW-1. Analysis of a rather complete suite of inorganic parameters would seem important to illuminate the cause of the higher conductivity. Also, the sample could be allowed to settle and then a conductivity reading taken of the clear portion to determine if there is a drop in conductivity. Because of the position of MW-1 downgradient from the bulk of plant

activities at SKF and also downgradient from the injection well, the possibility of some inorganic degradation of groundwater in the vicinity of the plant should not be dismissed lightly. More clarification is requested from the consultant.

2. Pending the results of the sludge bed and soil clean-up, I would see nothing wrong with a well located at the exact area of the sludge beds to determine water quality directly beneath the sludge beds. Such a well could also be used as an observation well for a pumping test on the pumped well to ascertain to what extent the pumping is influencing drawdown in the vicinity of the sludge beds, the presumed source of contamination. If badly contaminated, this well could also be used as an additional recovery well. The pumping well is located quite close to the sludge beds, but because the limestone is potentially so anisotropic, there is some doubt that it reflects worse groundwater quality conditions. There is also a question whether the pumping well is acting optimally as a contamination recovery well. The consultant's comments are requested.

3. What is the rationale for doing a rather complete suite of analyses downgradient of the plant at Spring Nos. 2, 3, 4, 5, and MW-5; and doing only TCE at the plant site wells? There may be other organic contaminants (e.g. DCE) at the plant site which have lower drinking water standards than the TCE. Until the well is sampled for a more complete analysis of volatile organics, it may be erroneous to conclude that groundwater recovery is not needed or that simply limiting TCE contamination to 4.5 ppb or less constitutes adequate response to groundwater pollution abatement.

4. The study does not establish with any certainty that recovery at the pumping well will contain and eventually recover all TCE contaminated groundwater. It appears likely that some groundwater contaminated above drinking water standards will not be recovered under the current proposal. Over 50% of the inferred area of groundwater contamination lies downgradient of the injection well and will likely be left to migrate downgradient. Dilution, dispersion, and perhaps some microbial decomposition would be relied upon to reduce this "unrecovered" portion of the contaminant plume to acceptable quality.

It appears from the review of the information submitted and the soil samples collected by the Department on October 29, 1984, that the sludge beds are responsible, at least in part, for the TCE contaminated groundwater.

When surface impoundments are closed and hazardous waste constituents remain in either the soil or groundwater, the impoundment must be closed as a landfill in conformance with all applicable landfill closure requirements. In addition, a Post-Closure application must be submitted to EPA and a Post-Closure Permit obtained. Post-Closure monitoring of the facility would also be a requirement. I would advise that you contact EPA, RCRA Permit Section Pat Anderson, Chief (3HW33), telephone (215) 597-9118 concerning specific requirements of a Post-Closure Permit.

Please review these comments and provide a response to this office within thirty (30) days of the receipt of this letter. If you have any questions or desire to meet with us concerning our review, please contact me.

Sincerely,

Robert G. Benvin

Robert G. Benvin
Facilities Supervisor
Harrisburg Regional Office

RGB:jvl

cc: U.S. Environmental Protection Agency

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 1021367

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #1 Collected 10/08/85 by NHI

ANALYSIS	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Chloride	67.	mg/l	4.	02240100C
Sulfate	100.	mg/l	10.	02280130C
Metals in Water		attached		05130900C
Volatiles in Groundwater		attached		05151000C

2 COPIES TO S.K.F. Industries ATTN: F. Bucceri

SEE REVERSE SIDE FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

01898 0.00 021300

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Richard C. Entz, B.A.
Group Leader, Organic Analysi

MAIN LABORATORY
2425 New Holland Pike, Lancaster, Pa. 17601 • (717) 656-2301

FRANKLIN DIVISION
5424 Buchanan Trail East, Waynesboro Pa 17268 • (717) 762-9127

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 1021 7

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #1 Collected 10/08/85 by NHI

Metals in Water	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Aluminum	3.8	mg/l	0.1	07580000N
Barium	0.063	mg/l	0.005	07590000N
Calcium	92.2	mg/l	0.05	07650000N
Cadmium	< 0.005	mg/l	0.005	07660000N
Chromium	< 0.05	mg/l	0.05	07670000N
Copper	< 0.05	mg/l	0.05	07690000N
Iron	21.0	mg/l	0.05	07700000N
Lead	< 0.05	mg/l	0.05	07710000N
Magnesium	19.1	mg/l	0.05	07730000N
Manganese	0.640	mg/l	0.005	07740000N
Molybdenum	< 0.05	mg/l	0.05	07750000N
Nickel	< 0.05	mg/l	0.05	07760000N
Potassium	2.8	mg/l	0.5	07780000N
Silver	< 0.05	mg/l	0.05	07820000N
Sodium	13.9	mg/l	0.5	07830000N
Zinc	< 0.05	mg/l	0.05	07890000N

2 COPIES TO S.K.F. Industries ATTN: F. Bucceri

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Respectfully Submitted
Lancaster Laboratories, I
Reviewed and Approved by:

Lee A. Seats, B.S. Group Ldr.
Inorganic Analysis

MAIN LABORATORY
2425 New Holland Pike. Lancaster, Pa 17601 • (717) 656-2301

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ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 1021367

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #1 Collected 10/08/85 by NHI

Volatiles in Groundwater	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Benzene	< 1.	ppb	1.	07030000N
Toluene	< 1.	ppb	1.	07040000N
Chlorobenzene	< 1.	ppb	1.	07050000N
Ethylbenzene	< 1.	ppb	1.	07060000N
Chloromethane	< 5.	ppb	5.	07110000N
Bromomethane	< 5.	ppb	5.	07120000N
2-Chloroethylvinyl ether	< 10.	ppb	10.	07130000N
Vinyl chloride	< 1.	ppb	1.	07140000N
Chloroethane	< 1.	ppb	1.	07150000N
Methylene chloride	< 1.	ppb	1.	07160000N
1,1-Dichloroethene	< 1.	ppb	1.	07170000N
1,1-Dichloroethane	< 1.	ppb	1.	07180000N
trans-1,2-Dichloroethene	< 1.	ppb	1.	07190000N
Chloroform	< 1.	ppb	1.	07200000N
1,2-Dichloroethane	< 1.	ppb	1.	07210000N
1,1,1-Trichloroethane	< 1.	ppb	1.	07220000N
Carbon tetrachloride	< 1.	ppb	1.	07230000N
Dichlorobromomethane	< 1.	ppb	1.	07240000N
1,2-Dichloropropane	< 1.	ppb	1.	07250000N
trans-1,3-Dichloropropene	< 1.	ppb	1.	07260000N
Trichloroethene	< 1.	ppb	1.	07270000N
Dibromochloromethane	< 1.	ppb	1.	07280000N
1,1,2-Trichloroethane	< 1.	ppb	1.	07290000N
cis-1,3-Dichloropropene	< 1.	ppb	1.	07300000N
Bromoform	< 2.	ppb	2.	07310000N
1,1,2,2-Tetrachloroethane	< 2.	ppb	2.	07320000N
Tetrachloroethene	< 1.	ppb	1.	07330000N

2 COPIES TO S.K.F. Industries ATTN: F. Bucceri

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Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Richard C. Entz, B.A.
Group Leader, Organic Analysi

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 1021 1

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #2 Collected 10/08/85 by NHI

ANALYSIS	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Chloride	7.	mg/l	4.	02240100C
Sulfate	20.	mg/l	10.	02280130C
Metals in Water		attached		05130900C
Volatiles in Groundwater		attached		05151000C

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SEE REVERSE SIDE FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

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Lancaster Laboratories, I
Reviewed and Approved by:

Richard C. Entz, B.A.
Group Leader, Organic Analysi

The American Association for Laboratory Accreditation
Chemical & Biological fields of testing

01898 0.00 021300

MAIN LABORATORY
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FRANKLIN DIVISION
5424 Buchanan Trail East, Waynesboro, Pa. 17268 • (717) 762-9127

ANALYSIS REPORT

08:38:08 106891
WLK212 D 2 5

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 1021368

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #2 Collected 10/08/85 by NHI

Metals in Water	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Aluminum	0.3	mg/l	0.1	07580000N
Barium	0.011	mg/l	0.005	07590000N
Calcium	17.5	mg/l	0.05	07650000N
Cadmium	< 0.005	mg/l	0.005	07660000N
Chromium	< 0.05	mg/l	0.05	07670000N
Copper	< 0.05	mg/l	0.05	07690000N
Iron	0.30	mg/l	0.05	07700000N
Lead	< 0.05	mg/l	0.05	07710000N
Magnesium	3.26	mg/l	0.05	07730000N
Manganese	< 0.005	mg/l	0.005	07740000N
Molybdenum	< 0.05	mg/l	0.05	07750000N
Nickel	< 0.05	mg/l	0.05	07760000N
Potassium	1.0	mg/l	0.5	07780000N
Silver	< 0.05	mg/l	0.05	07820000N
Sodium	4.8	mg/l	0.5	07830000N
Zinc	< 0.05	mg/l	0.05	07890000N

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5424 Buchanan Trail East, Waynesboro, Pa. 17268 • (717) 762-9127

ANALYSIS REPORT

08:38:11 106891
WLK212 D 2 5

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 10213o8

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #2 Collected 10/08/85 by NHI

Volatiles in Groundwater	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Benzene	< 1.	ppb	1.	07030000N
Toluene	< 1.	ppb	1.	07040000N
Chlorobenzene	< 1.	ppb	1.	07050000N
Ethylbenzene	< 1.	ppb	1.	07060000N
Chloromethane	< 5.	ppb	5.	07110000N
Bromomethane	< 5.	ppb	5.	07120000N
2-Chloroethylvinyl ether	< 10.	ppb	10.	07130000N
Vinyl chloride	< 1.	ppb	1.	07140000N
Chloroethane	< 1.	ppb	1.	07150000N
Methylene chloride	< 1.	ppb	1.	07160000N
1,1-Dichloroethene	< 1.	ppb	1.	07170000N
1,1-Dichloroethane	< 1.	ppb	1.	07180000N
trans-1,2-Dichloroethene	< 1.	ppb	1.	07190000N
Chloroform	71.	ppb	1.	07200000N
1,2-Dichloroethane	< 1.	ppb	1.	07210000N
1,1,1-Trichloroethane	< 1.	ppb	1.	07220000N
Carbon tetrachloride	< 1.	ppb	1.	07230000N
Dichlorobromomethane	2.	ppb	1.	07240000N
1,2-Dichloropropane	< 1.	ppb	1.	07250000N
trans-1,3-Dichloropropene	< 1.	ppb	1.	07260000N
Trichloroethene	< 1.	ppb	1.	07270000N
Dibromochloromethane	< 1.	ppb	1.	07280000N
1,1,2-Trichloroethane	< 1.	ppb	1.	07290000N
cis-1,3-Dichloropropene	< 1.	ppb	1.	07300000N
Bromoform	< 2.	ppb	2.	07310000N
1,1,2,2-Tetrachloroethane	< 2.	ppb	2.	07320000N
Tetrachloroethene	< 1.	ppb	1.	07330000N

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Lancaster Laboratories, Inc.
Reviewed and Approved by:

Richard C. Entz, B.A.
Group Leader, Organic Analysi

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08:38:17 106891
WLK212 D 2 5

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LLI Sample No. WW 1021369

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #3 Collected 10/08/85 by NHI

ANALYSIS	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Chloride	15.	mg/l	4.	02240100C
Sulfate	40.	mg/l	10.	02280130C
Metals in Water		attached		05130900C
Volatiles in Groundwater		attached		05151000C

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Richard C. Entz, B.A.
Group Leader, Organic Analysi

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WLK212 D 2 5

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 1021369

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #3 Collected 10/08/85 by NHI

Metals in Water	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Aluminum	0.4	mg/l	0.1	07580000N
Barium	0.033	mg/l	0.005	07590000N
Calcium	79.8	mg/l	0.05	07650000N
Cadmium	< 0.005	mg/l	0.005	07660000N
Chromium	< 0.05	mg/l	0.05	07670000N
Copper	< 0.05	mg/l	0.05	07690000N
Iron	2.94	mg/l	0.05	07700000N
Lead	< 0.05	mg/l	0.05	07710000N
Magnesium	17.5	mg/l	0.05	07730000N
Manganese	0.019	mg/l	0.005	07740000N
Molybdenum	< 0.05	mg/l	0.05	07750000N
Nickel	< 0.05	mg/l	0.05	07760000N
Potassium	2.2	mg/l	0.5	07780[illegible]N
Silver	< 0.05	mg/l	0.05	07820[illegible]N
Sodium	3.8	mg/l	0.5	07830000N
Zinc	< 0.05	mg/l	0.05	07890000N

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Inorganic Analysis

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Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #3 Collected 10/08/85 by NHI

Volatiles in Groundwater	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Benzene	< 1.	ppb	1.	07030000N
Toluene	< 1.	ppb	1.	07040000N
Chlorobenzene	< 1.	ppb	1.	07050000N
Ethylbenzene	< 1.	ppb	1.	07060000N
Chloromethane	< 5.	ppb	5.	07110000N
Bromomethane	< 5.	ppb	5.	07120000N
2-Chloroethylvinyl ether	< 10.	ppb	10.	07130000N
Vinyl chloride	< 1.	ppb	1.	07140000N
Chloroethane	< 1.	ppb	1.	07150000N
Methylene chloride	< 1.	ppb	1.	07160000N
1,1-Dichloroethene	< 1.	ppb	1.	07170000N
1,1-Dichloroethane	< 1.	ppb	1.	07180000N
trans-1,2-Dichloroethene	< 1.	ppb	1.	07190000N
Chloroform	< 1.	ppb	1.	07200000N
1,2-Dichloroethane	< 1.	ppb	1.	07210000N
1,1,1-Trichloroethane	< 1.	ppb	1.	07220000N
Carbon tetrachloride	< 1.	ppb	1.	07230000N
Dichlorobromomethane	< 1.	ppb	1.	07240000N
1,2-Dichloropropane	< 1.	ppb	1.	07250000N
trans-1,3-Dichloropropene	< 1.	ppb	1.	07260000N
Trichloroethene	< 1.	ppb	1.	07270000N
Dibromochloromethane	< 1.	ppb	1.	07280000N
1,1,2-Trichloroethane	< 1.	ppb	1.	07290000N
cis-1,3-Dichloropropene	< 1.	ppb	1.	07300000N
Bromoform	< 2.	ppb	2.	07310000N
1,1,2,2-Tetrachloroethane	< 2.	ppb	2.	07320000N
Tetrachloroethene	< 1.	ppb	1.	07330000N

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Group Leader, Organic Analysi

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08:38:27 106891
WLK212 D 2 5

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 10213/0

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #4 Collected 10/08/85 by NHI

ANALYSIS	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Chloride	13.	mg/l	4.	022401000
Sulfate	30.	mg/l	10.	022801300
Metals in Water		attached		051309000
Volatiles in Groundwater		attached		051510000

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Group Leader, Organic Analysi

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WLK212 D 2 5

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 1021370

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #4 Collected 10/08/85 by NHI

Metals in Water	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Aluminum	0.1	mg/l	0.1	07580000N
Barium	0.033	mg/l	0.005	07590000N
Calcium	84.3	mg/l	0.05	07650000N
Cadmium	< 0.005	mg/l	0.005	07660000N
Chromium	< 0.05	mg/l	0.05	07670000N
Copper	< 0.05	mg/l	0.05	07690000N
Iron	0.27	mg/l	0.05	07700000N
Lead	< 0.05	mg/l	0.05	07710000N
Magnesium	15.3	mg/l	0.05	07730000N
Manganese	< 0.005	mg/l	0.005	07740000N
Molybdenum	< 0.05	mg/l	0.05	07750000N
Nickel	< 0.05	mg/l	0.05	07760000N
Potassium	1.9	mg/l	0.5	07780000N
Silver	< 0.05	mg/l	0.05	07820000N
Sodium	3.4	mg/l	0.5	07830000N
Zinc	< 0.05	mg/l	0.05	07890000N

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Inorganic Analysis

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Lancaster Laboratories INCORPORATED

LLI Sample No. WW 1021370

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #4 Collected 10/08/85 by NHI

Volatiles in Groundwater	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Benzene	< 1.	ppb	1.	07030000N
Toluene	< 1.	ppb	1.	07040000N
Chlorobenzene	< 1.	ppb	1.	07050000N
Ethylbenzene	< 1.	ppb	1.	07060000N
Chloromethane	< 5.	ppb	5.	07110000N
Bromomethane	< 5.	ppb	5.	07120000N
2-Chloroethylvinyl ether	< 10.	ppb	10.	07130000N
Vinyl chloride	< 1.	ppb	1.	07140000N
Chloroethane	< 1.	ppb	1.	07150000N
Methylene chloride	< 1.	ppb	1.	07160000N
1,1-Dichloroethene	< 1.	ppb	1.	07170000N
1,1-Dichloroethane	< 1.	ppb	1.	07180000N
trans-1,2-Dichloroethene	< 1.	ppb	1.	07190000N
Chloroform	< 1.	ppb	1.	07200000N
1,2-Dichloroethane	< 1.	ppb	1.	07210000N
1,1,1-Trichloroethane	< 1.	ppb	1.	07220000N
Carbon tetrachloride	< 1.	ppb	1.	07230000N
Dichlorobromomethane	< 1.	ppb	1.	07240000N
1,2-Dichloropropane	< 1.	ppb	1.	07250000N
trans-1,3-Dichloropropene	< 1.	ppb	1.	07260000N
Trichloroethene	< 1.	ppb	1.	07270000N
Dibromochloromethane	< 1.	ppb	1.	07280000N
1,1,2-Trichloroethane	< 1.	ppb	1.	07290000N
cis-1,3-Dichloropropene	< 1.	ppb	1.	07300000N
Bromoform	< 2.	ppb	2.	07310000N
1,1,2,2-Tetrachloroethane	< 2.	ppb	2.	07320000N
Tetrachloroethene	< 1.	ppb	1.	07330000N

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Group Leader, Organic Analysi

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WLK212 D 2 5

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 1021371

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #5 Collected 10/08/85 by NHI

ANALYSIS	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Chloride	20.	mg/l	4.	02240100C
Sulfate	30.	mg/l	10.	02280130C
Metals in Water		attached		05130900C
Volatiles in Groundwater		attached		05151000C

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Group Leader, Organic Analysi

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WLK212 D 2 5

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 1021371

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #5 Collected 10/08/85 by NHI

Metals in Water	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Aluminum	0.2	mg/l	0.1	07580000N
Barium	0.051	mg/l	0.005	07590000N
Calcium	90.5	mg/l	0.05	07650000N
Cadmium	< 0.005	mg/l	0.005	07660000N
Chromium	< 0.05	mg/l	0.05	07670000N
Copper	< 0.05	mg/l	0.05	07690000N
Iron	0.20	mg/l	0.05	07700000N
Lead	< 0.05	mg/l	0.05	07710000N
Magnesium	15.9	mg/l	0.05	07730000N
Manganese	< 0.005	mg/l	0.005	07740000N
Molybdenum	< 0.05	mg/l	0.05	07750000N
Nickel	< 0.05	mg/l	0.05	07760000N
Potassium	2.1	mg/l	0.5	07780000N
Silver	< 0.05	mg/l	0.05	07820000N
Sodium	7.4	mg/l	0.5	07830000N
Zinc	< 0.05	mg/l	0.05	07890000N

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Inorganic Analysis

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Lancaster Laboratories INCORPORATED

LLI Sample No. WW 1021371

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/29/85
Date Submitted 10/ 9/85
Discard Date 11/ 5/85
Collected by
P.O. 4010213
Rel.

Well #5 Collected 10/08/85 by NHI

Volatiles in Groundwater	RESULT AS RECEIVED		LIMIT OF DETECTION	LAB CODE
Benzene	< 1.	ppb	1.	07030000N
Toluene	< 1.	ppb	1.	07040000N
Chlorobenzene	< 1.	ppb	1.	07050000N
Ethylbenzene	< 1.	ppb	1.	07060000N
Chloromethane	< 5.	ppb	5.	07110000N
Bromomethane	< 5.	ppb	5.	07120000N
2-Chloroethylvinyl ether	< 10.	ppb	10.	07130000N
Vinyl chloride	< 1.	ppb	1.	07140000N
Chloroethane	< 1.	ppb	1.	07150000N
Methylene chloride	< 1.	ppb	1.	07160000N
1,1-Dichloroethene	< 1.	ppb	1.	07170000N
1,1-Dichloroethane	< 1.	ppb	1.	07180000N
trans-1,2-Dichloroethene	< 1.	ppb	1.	07190000N
Chloroform	1.	ppb	1.	07200000N
1,2-Dichloroethane	< 1.	ppb	1.	07210000N
1,1,1-Trichloroethane	< 1.	ppb	1.	07220000N
Carbon tetrachloride	< 1.	ppb	1.	07230000N
Dichlorobromomethane	< 1.	ppb	1.	07240000N
1,2-Dichloropropane	< 1.	ppb	1.	07250000N
trans-1,3-Dichloropropene	< 1.	ppb	1.	07260000N
Trichloroethene	< 1.	ppb	1.	07270000N
Dibromochloromethane	< 1.	ppb	1.	07280000N
1,1,2-Trichloroethane	< 1.	ppb	1.	07290000N
cis-1,3-Dichloropropene	< 1.	ppb	1.	07300000N
Bromoform	< 2.	ppb	2.	07310000N
1,1,2,2-Tetrachloroethane	< 2.	ppb	2.	07320000N
Tetrachloroethene	< 1.	ppb	1.	07330000N

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FRANKLIN DIVISION
5424 Buchanan Trail East, Waynesboro, Pa 17268 • (717) 762-9127

SKF ROLLER BEARINGS DIVISION
SKF INDUSTRIES
SHIPPENSBURG, PENNSYLVANIA

STUDY OF THE SOURCE AND EXTENT OF TCE CONTAMINATION OF GROUND WATER

FINAL

PREPARED BY:

NASSAUX-HEMSLEY, INCORPORATED
56 NORTH SECOND STREET
CHAMBERSBURG, PENNSYLVANIA

OCTOBER 1984

SKF ROLLER BEARINGS DIVISION
SKF INDUSTRIES
SHIPPENSBURG, PENNSYLVANIA

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OCTOBER 1984

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SHIPPENSBURG, PENNSYLVANIA

STUDY OF THE SOURCE AND EXTENT OF TCE CONTAMINATION OF GROUND WATER

- TABLE OF CONTENTS -

I.

INTRODUCTION

In June 1984, Nassaux-Hemsley, Incorporated (NHI) was retained by SKF Roller Bearings Division of SKF Industries to conduct a hydrogeologic study of the source and extent of Trichloroethylene (TCE) contamination of ground water in the area of SKF's Shippensburg Plant. This Report presents the results of that study.

The scope of the study was based on a June 11, 1984, Proposal submitted by NHI to SKF. After preliminary discussions with SKF, the study was expanded to include a study of the feasibility of using an air stripping tower to remove TCE from contaminated ground water withdrawn by SKF. This contaminated ground water is current withdrawn at an on-site pumping well, used for non-contact cooling, and then reinjected in an on-site injection well.

The air stripping study was conducted by Oil Recovery Systems, Incorporated acting as a subcontractor to NHI. The conclusions of their study were presented as a separate letter report dated September 21, 1984, which is included in Appendix D.

II.

GENERAL SETTING

The SKF Plant is situated on the south side of West King Street, in the southwest corner of Shippensburg Borough, Franklin County, Pennsylvania. The south side of the plant is bounded by railroad tracts. The site is in carbonate (limestone and dolomite) lowland terrain in the Cumberland Valley.

Surface drainage is to the east toward north flowing Middle Spring Creek, which flows through the center of Shippensburg.

The area to the northwest, north and east of the plant is high density residential, industrial and commercial, served by public water and sewer. Open space occurs to the south, beyond the railroad tracts, as a result the Shippensburg Fairgrounds, farmland and undeveloped areas. Low density residential development occurs to the southwest and south in Southampton Township. Water supplies in these areas are predominantly individual on-site wells.

The plant location and surrounding area are shown on the enlarged USGS Topographic Map and enlarged USGS aerial photograph which accompany this Report as Exhibits I and II.

III.

PROBLEM BACKGROUND

In 1983, the Pennsylvania Department of Environmental Resources (PaDER) sampled the SKF pumping well and determined that the ground water withdrawn by this well was contaminated by TCE. Subsequent sampling showed TCE concentration at this well to be in the range of 10 to 31 ppb as reported by Lancy Labs and Lancaster Labs. As SKF uses TCE in its processing at the Shippensburg Plant, the plant was considered by PaDER as a possible source of the contamination. The use of TCE will be discontinued at the plant at the end of 1984.

SKF uses their pumping well for most of its water needs. This well withdraws 100-150 gpm of groundwater. Some water is also taken from the Shippensburg public water supply. Non-contact cooling water is currently reinjected into an on-site injection well at a rate of approximately 100 gpm. Waste water including sewage and pretreated process waste water is currently directed to the public sewer. In the past, process water was directed to the injection well after treatment, along with the cooling water, under permit from PaDER for direct injection.

PaDER's 1983 sampling disclosed that the TCE contaminated ground water withdrawn by the pumping well was being reinjected at the injection well with little decrease or increase in TCE concentration.

The injection well currently used by SKF was drilled in 1975, to replace an older injection well which had become partially plugged.

In August 1983, PaDER conducted a survey of ground water quality in the plant area by sampling several nearby wells, a spring, and a water filled cave. These sampling points are situated to the northeast, east, and south of the plant. No TCE was detected at any of these sampling points. SKF conducted their own survey

in October 1983, by sampling several wells and a spring in the area. These sampling points are located to the south and north of the plant. As with PaDER's survey, no TCE was discovered in SKF's samples. The locations of PaDER's sampling points and two of SKF's sampling points situated closest to the plant are shown on Exhibit I. The lab reports for PaDER's and SKF's preliminary surveys are included in Appendix A.

The SKF plant was established in the late 1940's, in an existing building which is reported to have been a furniture factory dating to the early 1900's. The use of TCE at the SKF Plant began in the mid 1960's.

SKF began monthly sampling of their pumping well, injection well return flow, and sewer discharge in September 1983, and have continued that sampling to the present. This data provided an interesting insight to the source of TCE contamination as will be discussed later in this Report.

The ground water study discussed herein is part of a larger effort by SKF to upgrade their wastewater handling system and phase-out certain elements of their older waste water handling system.

Much of the study and design for this system upgrade is being conducted by Lancy International. Portions of Lancy's studies will be referenced in this report where appropriate.

IV.

HYDROGEOLOGIC SETTING AND MONITORING WELL INSTALLATION

The problem area is underlain by folded carbonate bedrock (limestone and dolomite). In such rocks, ground flows along joints, bedding plane partings or other fractures, any of which can be enlarged by solutioning of the rock. This results in anisotropic or directional permeabilities. Ground water is usually predicted to flow in the direction of the water table gradient, but, due to the anisotropic permeability of these rocks, ground water may flow oblique to the gradient, along the trend of bedding or along specific fractures or fractured zones.

The Rockdale Run formation is the primary formation in the site area. The Shady Grove formation underlies the lower terrain to the east of the plant. The characteristics of these formations are summarized on Exhibit I.

The plant area is on or near the axis of a west plunging anticline (upfold in the rock). The south limb of this anticline terminates against the Shippensburg fault, which trends east-west, passing through the Fairgrounds to the south of the plant. In the plant area bedrock strikes (trends) northwest and dips to the southwest. Northeast of the plant along King Street, exposed bedrock strikes northeast and dips northwest.

The strike and dip of bedding at several outcrops in the plant area is shown on Exhibit I. Joint measurements are also shown on this Exhibit.

Lineaments or fracture traces are zones of concentrated or prominent fracturing which are manifest as linear topographic or tonal features on aerial photographs. Fracture traces mapped

in the site area are shown on Exhibit I. East-northeast trending lineaments are manifest by east northeast trending valleys in the site area. One of these valleys begins in the plant area and follows Orange Street towards Middle Spring Creek.

An historic, water-filled cave occurs just off of the SKF property northwest of the plant as shown on Exhibit I. This cave formed along northeast trending jointing. It was used as a local water supply as early as colonial times, and the land owner reports that it is known as "Indian Head" Cave. The land owner also reports that the water in the cave is flowing slowly from southwest to northeast.

Sinkholes are another result of solutioned voids or channels in bedrock. A sink hole was reported to have been enclosed by the SKF plant building as shown on Exhibit II.

Four (4) monitoring wells designated MW1 through MW4 were installed on SKF property in July and August 1984. Well sites were chosen in accessible portions of the plant property, on fracture traces where possible. Well MW1 was chosen on the north side of the plant; Well MW2 on the west side; Well MW3 on the east side; and Well MW4 northeast of the plant along the east-northeast trending valley/fracture trace following Orange Street. An additional water level monitoring point was provided by the old, partially blocked injection well. The pumping well is capped without an access port for water level monitoring, and hence the water level in the pumping well could not be monitored during the study.

Static water levels in the four (4) new monitoring wells and old injection well were monitored during July and August, and the elevation of the top-of-casing of each well was established by NHI surveyors. These elevations were tied to a U.S.G.S. Bench Mark. From this data, the water table was contoured. The initial water table contouring disclosed a regional water table gradient to the north. As a result of this northward gradient and

initial water quality sampling to be discussed later, a fifth monitoring well, designated MW5, was added in late September on an accessible off-site property situated north of the plant. Logs of the new monitoring wells and of the injection well and pumping well are included in Appendix B.

In this hydrogeologic setting, with a northerly water table gradient, several structurally controlled directions of ground water flow are possible, including:

1. Northwest along bedding strike on the south limb of the fold;
2. East-northeast or northeast along jointing or fracturing, particularly in the axis of the fold; and
3. Northeast along bedding strike on the north limb of the fold.

Numerous springs occur in the Region as shown on Exhibit I. Four (4) springs which are located on the west side of Middle Spring Creek, have been designated #2 through #5 on Exhibit I. Spring #2 actually consists of two (2) smaller springs whose flows are piped together in an alley north of King Street. Dykeman Spring, which is a source for the Shippensburg Water Supply, is located east of Middle Spring Creek. Spring #5 and Dykeman Spring appear to be related to the Shippensburg Fault.

The SKF pumping well is located approximately 250 feet south of the injection wells. Some recirculation of injected water to the pumping well has been conjectured in the past. Temperature monitoring, to be discussed in a following section, disclosed that the bulk of the reinjected water is probably not returning to the pumped well.

Pumping forms a cone of depression in the water table, while injection forms a mound in the water table. Measured water levels confirmed the mound in the area of the injection well, and the probable pumping cone has been imposed on the interpreted water table contours.

V.

GROUND WATER SAMPLING PROGRAM

In August 1984, Monitoring Wells MW1 through MW4 were pumped to purge drilling water and stagnant water in the bore, and sampled. Indian Head Cave, the SKF production well and the reinjected water at the injection well were sampled on the same date. Monitoring Well MW5 and four (4) springs in the area were sampled in late September 1982. As with the other wells, Well MW5 was pumped/purged prior to sampling. One of the four spring samples (Spring #4) was broken in transit to the laboratory, and this spring was resampled in early October 1984. All NHI samples were analyzed by Lancaster Laboratories, and the laboratory results are presented in Appendix A along with the results of previously collected samples.

As a quality control check, the first round samples from Wells MW1 through MW4, Indian Head Cave, the production and injection wells were all split, and the split samples sent to Lancy Labs by SKF. Lancy Labs' results agreed quite well with Lancaster Labs' results. Lancy's reports are included in Appendix A.

VI.

TEMPORAL AND SPATIAL PATTERN OF POLLUTION

As a preliminary screening, temperature and conductivity logs were completed on the four (4) new monitoring wells in the plant area in late August 1984. Temperature and conductivity readings were also taken on water from the pumping well, cooling water at the injection well, and on water in Indian Head Cave. Temperature and conductivity data is presented in Appendix C and on Exhibit II.

Conductivity readings clustered in the range of 330 to 400 micromhos/cm, except MW2 which showed a low conductivity of 157-178 micromhos/cm, and MW1 which showed a high conductivity of 592 micromhos/cm. The high conductivity in MW1 is interpreted to result from high turbidity stemming from a "running mud" seam encountered in MW1. The low conductivity in MW2 suggests a different zone of ground water flow or quality.

Ground water temperatures are plotted on Exhibit II. Temperatures plotted for Wells MW1 through MW4 are those temperatures below the cased interval. Background ground water temperature is in the range of 10.9° to 11.5°C. (51.6° to 52.7°F.), as defined at the two stations most distant from the plant, Indian Head Cave, and MW4.

The cooling water at the injection well had a temperature of 19.9° to 21.5° (67.8° to 70.7°F). Above background temperatures were measured in MW1 and MW2 suggesting that these wells are in the zone affected by the warm injected cooling water. Interestingly, the pumping well showed a near background temperature of 11.5°C. (52.7°F.). If a significant amount of reinjected cooling water were recirculating to the pumping well, the pumping well water should be considerably above background,

particularly because the injection and pumping wells are only 250' apart. Based on this data, significant recirculation from the injection well to the pumping well is not occurring.

TCE concentrations for the August through October 1984 samplings are shown on Exhibits I and II. The highest TCE concentrations of 14 to 15 ppb were at the pumping and injection wells. The concentration was only 7.4 ppb at MW1 and 0.9 ppb at MW3. TCE was not detected (less than 0.5 ppb) in MW2 and MW4. The presence of TCE in MW1 is consistent with the temperature data, however, its absence in MW2 is inconsistent with the temperature data. Water level data show MW2 to have the highest water level elevation (greater than 658). This high level and its anomalously low conductivity indicate that it is a background well.

No TCE was detected off-site above drinking water limits (4.5 ppb). No TCE was detected in MW5, Indian Head Cave, Spring #4, Spring #2, or Spring #5. TCE was detected at 3 ppb in Spring #3.

The worst case scenario is that TCE has migrated to the northeast from the SKF Plant past MW5 to Spring #3. This does not seem likely assuming any amount of lateral dispersion of contaminants, but it is possible considering potential structural controls on ground water flow such as strike parallel flow to the northeast. Spring #3 is directly along the trace of bedding from the SKF Plant. Even so, the off-site concentration of TCE at Spring #3 is within drinking water limits, and there are other possible contamination sources such as Spring Hill Cemetery, other industries to the northwest of the SKF Plant, and even the residential area to the north of the SKF Plant.

What is apparent from all of this data is that there is no area of TCE contamination of ground water stemming from the SKF Plant that is of high enough concentration to warrant an extensive ground water recovery program.

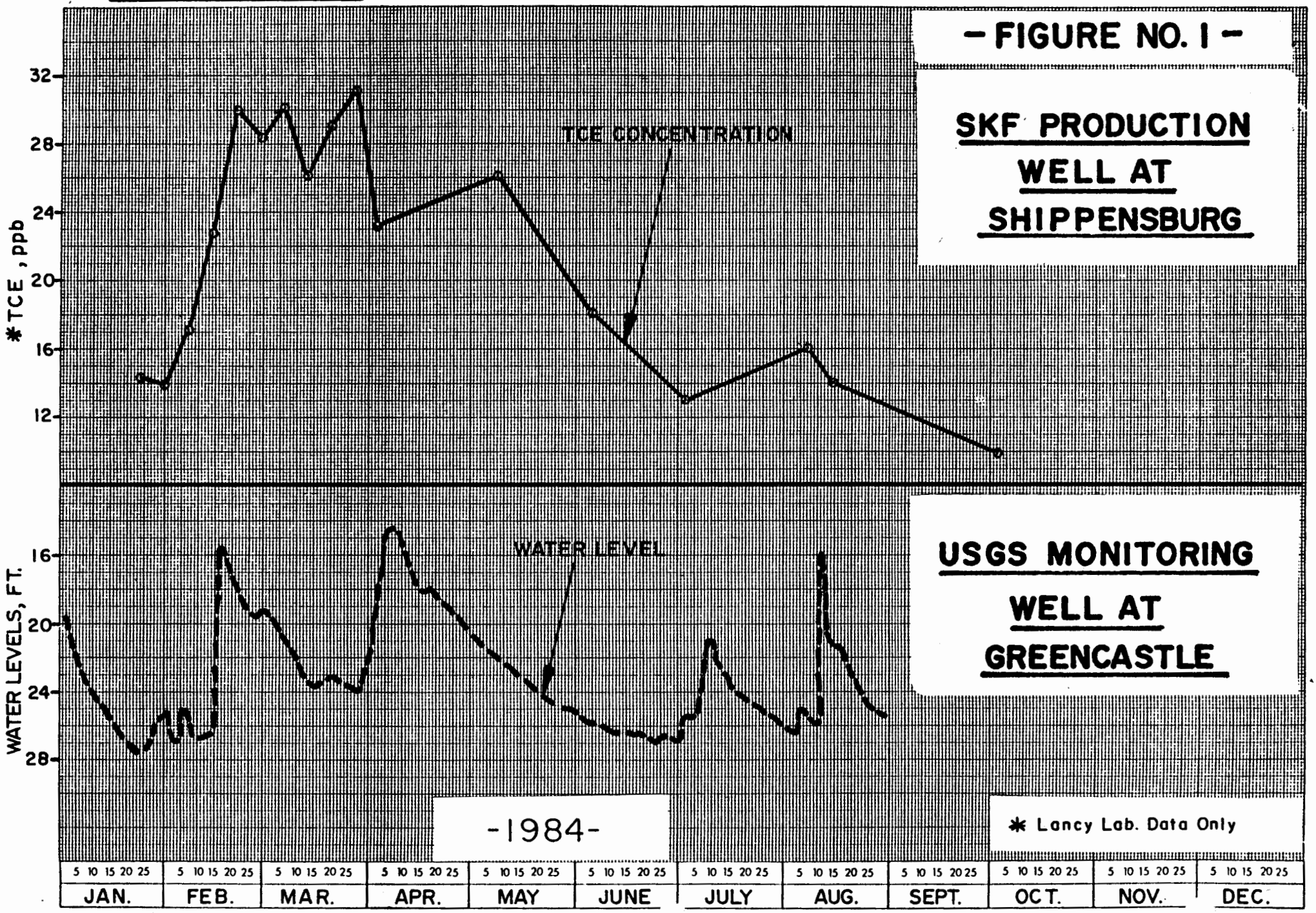
The variation of TCE concentration with time at the SKF pumping well yields an answer as to the source of the TCE contamination. Figure #1 contains a plot of TCE vs. time for the period January through October 1984. Only data from Lancy Labs is used to avoid inconsistencies between laboratory results. Also plotted is the hydrograph of the nearest U.S.G.S. observation well which is in carbonate terrain at Greencastle, approximately 22 miles south the project area. This hydrograph covers the same period, January through October 1984. High or rising water levels at the U.S.G.S. well represent periods when rainfall or snow melt infiltrated to the water table as recharge. Periods of low or declining water levels at the well represent periods when no or little rainfall or snow melt infiltrated to the water table.

The TCE concentration at the SKF pumping well rose from a concentration of 14 ppb in January to a high of 22 to 31 ppb during the period Mid-February through early May. The TCE concentration declined through early July, rising slightly in early August and declining to a low 10 ppb in early October. The correlation between this temporal variation in TCE and the U.S.G.S. well hydrograph is excellent. TCE at the SKF pumping well obviously increases during periods of high rainfall or snowmelt infiltration and decreases in the absense of such infiltration.

This simple correlation indicates that the source of TCE at the SKF pumping well is TCE retained in the soil above the water table. The highest concentrations of TCE occur when infiltrating rain water or snow melt dissolves or flushes this TCE from the soil, and then the concentration at the pumping well declines in the absence of infiltration as the pumping well purges the TCE contaminated ground water. This is, by the way, another indication that significant recirculation of water between the

SKF INDUSTRIES
PRODUCTION WELL

TCE vs. TIME / GROUND WATER LEVELS vs. TIME



injection and pumping well is not occurring. If it were, the concentration of TCE would not decline so readily at the pumping well, as the reinjected water has approximately the same TCE concentration as the pumped water. Recirculation would tend to maintain a near constant TCE concentration.

A study by Lancy International has disclosed the presence of TCE in the soil beneath old sludge beds (see Exhibit II) near the SKF pumping well. TCE was found at a depth of 0 to 3 feet to be 215 ppm (215,000 ppb). Considering the proximity of these beds to the pumping well, they are the most likely source of the contamination. If this contaminated soil in the old sludge beds is removed, and the ground water contamination still persists, the possibility of other areas of soil contamination by TCE should be investigated.

If all significant TCE contaminated soil is removed and if an air-stripper is installed to reduce TCE at the reinjected water to within drinking water limits, the limited area of TCE contamination of ground water within the plant property should be effectively eliminated within a few years.

VII.

CONCLUSIONS AND RECOMMENDATIONS

1. The highest concentration of TCE in ground water on-site occurs near the pumping and injection wells. This was in the range of 14-15 ppb during the study.

2. Ground water flow is to the north or northeast based on the water table gradient and possible structural controls on ground water flow.

3. TCE was not detected at all but one off-site sampling station. At this one point, identified as Spring #3, TCE is only 3 ppb, less than the 4.5 ppb drinking water maximum.

4. Ground water recovery is not warranted.

5. The temporal pattern of TCE at the pumping well points to TCE contaminated soil as the source of the TCE.

6. The problem can be effectively eliminated by removing all significant TCE contaminated soil and by treating the reinjected cooling water with an air stripper.

7. Continue monitoring to document effectiveness of clean-up.

APPENDIX A
WATER QUALITY DATA

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 325781

Date Reported 8/30/84
Date Submitted 8/27/84
Discard Date 9/ 6/84
P. O. No. none
Collected by Client

Nassaux-Hemsley Inc.
56 North Second Street
Chambersburg, PA 17201

MW #1 Water Sample

ANALYSIS	AS RECEIVED		LAB CODE
Trichloroethylene	7.4	ppb	418-070-005(

2 COPIES TO Nassaux-Hemsley Inc. Attn: Gordon Lambert

SEE REVERSE SIDE FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

Prep 45.00 Total 50.00 299 Respectfully submitted
Lancaster Laboratories, Inc.

MAIN LABORATORY
2425 New Holland Pike Lancaster Pa 17601 • (717) 656-2301

FRANKLIN DIVISION
5424 Buchanan Trail East Waynesboro Pa 17268 • (717) 762-9131

Reviewed and Approved by:
Nelson H. Risser, B.A.
Tech. Assoc. Instrumental Proc

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No WW 333834

Date Reported 10/17/84
Date Submitted 10/ 2/84
Discard Date 10/24/84
Collected by Client

Nassaux-Hemsley Inc.
56 North Second Street
Chambersburg, PA 17201

Spring #5 Water Sample
Collected 9/28/84 by SKF

Volatiles in Groundwater	AS RECEIVED		
Benzene	<	1.	ppb
Toluene	<	1.	ppb
Chlorobenzene	<	1.	ppb
Ethylbenzene	<	1.	ppb
Chloromethane	<	5.	ppb
Bromomethane	<	5.	ppb
2-Chloroethylvinyl ether	<	10.	ppb
Vinyl chloride	<	1.	ppb
Chloroethane	<	1.	ppb
Methylene chloride	<	1.	ppb
1,1-Dichloroethene	<	1.	ppb
1,1-Dichloroethane	<	1.	ppb
trans-1,2-Dichloroethene	<	1.	ppb
Chloroform	<	1.	ppb
1,2-Dichloroethane	<	1.	ppb
1,1,1-Trichloroethane	<	1.	ppb
Carbon tetrachloride	<	1.	ppb
Dichlorobromomethane	<	1.	ppb
1,2-Dichloropropane	<	1.	ppb
trans-1,3-Dichloropropene	<	1.	ppb
Trichloroethene	<	1.	ppb
Dibromochloromethane	<	1.	ppb
1,1,2-Trichloroethane	<	1.	ppb
cis-1,3-Dichloropropene	<	1.	ppb
Bromoform	<	2.	ppb
1,1,2,2-Tetrachloroethane	<	2.	ppb
Tetrachloroethene	<	1.	ppb

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MAIN LABORATORY:
2425 New Holland Pike, Lancaster, Pa. 17601 • (717) 656-2301

FRANKLIN DIVISION:
5424 Buchanan Trail East, Waynesboro, Pa. 17268 • (717) 762-9[illegible]

Respectfully submitted,
Lancaster Laboratories, Inc.

Reviewed and Approved by
Nelson H. Risser, B.A.
Group Leader, GC/MS

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No WW 333835

Date Reported 10/17/84
Date Submitted 10/ 2/84
Discard Date 10/24/84
Collected by Client

Nassaux-Hemsley Inc.
56 North Second Street
Chambersburg, PA 17201

MW #5 Water Sample
Collected 9/28/84 by SKF

Volatiles in Groundwater	AS RECEIVED		
Benzene	<	1.	ppb
Toluene	<	1.	ppb
Chlorobenzene	<	1.	ppb
Ethylbenzene	<	1.	ppb
Chloromethane	<	5.	ppb
Bromomethane	<	5.	ppb
2-Chloroethylvinyl ether	<	10.	ppb
Vinyl chloride	<	1.	ppb
Chloroethane	<	1.	ppb
Methylene chloride	<	1.	ppb
1,1-Dichloroethene	<	1.	ppb
1,1-Dichloroethane	<	1.	ppb
trans-1,2-Dichloroethene	<	1.	ppb
Chloroform	<	1.	ppb
1,2-Dichloroethane	<	1.	ppb
1,1,1-Trichloroethane	<	1.	ppb
Carbon tetrachloride	<	1.	ppb
Dichlorobromomethane	<	1.	ppb
1,2-Dichloropropane	<	1.	ppb
trans-1,3-Dichloropropene	<	1.	ppb
Trichloroethene	<	1.	ppb
Dibromochloromethane	<	1.	ppb
1,1,2-Trichloroethane	<	1.	ppb
cis-1,3-Dichloropropene	<	1.	ppb
Bromoform	<	2.	ppb
1,1,2,2-Tetrachloroethane	<	2.	ppb
Tetrachloroethene	<	1.	ppb

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MAIN LABORATORY
2425 New Holland Pike Lancaster Pa 17601 • (717) 656-2301

FRANKLIN DIVISION
5424 Buchanan Trail East Waynesboro Pa 17268 • (717) 762-9[illegible]

Respectfully submitted,
Lancaster Laboratories, Inc.

Reviewed and Approved by
Nelson H. Risser, B.A.
Group Leader, GC/MS

09:26:47- 59678 - 36 - 1 Y D WLK 000

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 261387

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/17/83
Date Submitted 10/11/83
Discard Date 10/24/83
P. O. No. 4-000200
Collected by Client

DS
Water Sample

ANALYSIS	AS RECEIVED		LAB CODE
Trichloroethylene	< 0.5	ppb	418-049-005

1 COPY TO S.K.F. Industries Attn: R. Sterken / C. Hocking

PRIVATE WELL

SEIBERT

SEE EXHIBIT I

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Prep 45.00 Total 50.00 1898 Respectfully submitted
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J. Wilson Hershey

J. Wilson Hershey M.S. Mgr.

MAIN LABORATORY
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FRANKLIN DIVISION
5424 Buchanan Trail East Waynesboro Pa 17268 • (717) 762-3121

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ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 261385

Date Reported 10/17/83
Date Submitted 10/11/83
Discard Date 10/24/83
P. O. No. 4-000200
Collected by Client

S.K.F. Industries
West King Street
Shippensburg, PA 17257

LW
Water Sample

ANALYSIS	AS RECEIVED		LAB CODE
Trichloroethylene	< 0.5	ppb	418-049-005

1 COPY TO S.K.F. Industries Attn: R. Sterken / C. Hocking

PRIVATE WELL

WENGER

SOUTH ON RTE 696

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J. Wilson Hershey M.S. Mgr.

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FRANKLIN DIVISION
5425 Buchanan Trl East Waynesboro Pa 17268 • 717 762-[illegible]

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 261386

Date Reported 10/17/83
Date Submitted 10/11/83
Discard Date 10/24/83
P. O. No. 4-000200
Collected by Client

S.K.F. Industries
West King Street
Shippensburg, PA 17257

OH
Water Sample

ANALYSIS	AS RECEIVED		LAB CODE
Trichloroethylene	< 0.5	ppb	418-049-005C

1 COPY TO S.K.F. Industries Attn: R. Sterken / C. Hocking

PRIVATE WELL
VILLAGE OF MIDDLE SPRING

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J. Wilson Hershey M.S. Mgr.

MAIN LABORATORY
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FRANKLIN DIVISION
5424 Buchanan Trail East Waynesboro Pa 17268 • (717) 762-3121

09:27:03- 59678 - 36 - 1 Y D WLK 000

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 261388

S.K.F. Industries
West King Street
Shippensburg, PA 17257

Date Reported 10/17/83
Date Submitted 10/11/83
Discard Date 10/24/83
P. O. No. 4-000200
Collected by Client

AZF
Water Sample

ANALYSIS	AS RECEIVED		LAB CODE
Trichloroethylene	< 0.5	ppb	418-049-005(

1 COPY TO S.K.F. Industries Attn: R. Sterken / C. Hocking

PRIVATE WELL
FRY

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Lancaster Laboratories, Inc.

J. Wilson Hershey

J. Wilson Hershey M.S. Mgr.

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ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 261389

Date Reported 10/17/83
Date Submitted 10/11/83
Discard Date 10/24/83
P. O. No. 4-000200
Collected by Client

S.K.F. Industries
West King Street
Shippensburg, PA 17257

MS
Water Sample

ANALYSIS	AS RECEIVED		LAB CODE
Trichloroethylene	< 0.5	ppb	418-049-005C

1 COPY TO S.K.F. Industries Attn: R. Sterken / C. Hocking

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FRANKLIN DIVISION
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ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 325782

Date Reported 8/30/84
Date Submitted 8/27/84
Discard Date 9/ 6/84
P. O. No. none
Collected by Client

Nassaux-Hemsley Inc.
56 North Second Street
Chambersburg, PA 17201

MW #2 Water Sample

ANALYSIS	AS RECEIVED		LAB CODE
Trichloroethylene	< 0.5	ppb	418-070-005(

2 COPIES TO Nassaux-Hemsley Inc. Attn: Gordon Lambert

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Prep 45.00 Total 50.00 299 Respectfully submitted
Lancaster Laboratories, Inc.

Reviewed and Approved by:
Nelson H. Risser, B.A.
Tech. Assoc. Instrumental Proc

MAIN LABORATORY
2425 New Holland Pike Lancaster Pa 17601 • (717) 656-2301

FRANKLIN DIVISION
5424 Buchanan Trail East Waynesboro Pa 17268 • (717) 762-2121

08:43:43- 00825 - 7 - 3 Y M WLK 036

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. WW 325783

Date Reported 8/30/84
Date Submitted 8/27/84
Discard Date 9/ 6/84
P. O. No. none
Collected by Client

Nassaux-Hemsley Inc.
56 North Second Street
Chambersburg, PA 17201

MW #3 Water Sample

ANALYSIS	AS RECEIVED		LAB CODE
Trichloroethylene	0.9	ppb	418-070-005

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MHR

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Nelson H. Risser, B.A.
Tech. Assoc. Instrumental Proc

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2425 New Holland Pike Lancaster Pa 17601 • (717) 656-2301

FRANKLIN DIVISION
5124 Buchanan Trail East Waynesboro Pa 17268 • (717) 762-9121

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ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

L.L.I Sample No. WW 325784

Date Reported 8/30/84
Date Submitted 8/27/84
Discard Date 9/ 6/84
P. O. No. none
Collected by Client

Nassaux-Hemsley Inc.
56 North Second Street
Chambersburg, PA 17201

MW #4 Water Sample

ANALYSIS	AS RECEIVED		LAB CODE
Trichloroethylene	< 0.5	ppb	418-070-005

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Reviewed and Approved by:
Nelson H. Risser, B.A.
Tech. Assoc. Instrumental Proc

MAIN LABORATORY
2425 New Holland Pike Lancaster Pa 17601 • (717) 656-2301

FRANKLIN DIVISION
6424 Buchanan Trl East Waynesboro Pa 17268 • (717) 762-2191